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ABSTRACT

Reviewed is an American Institutes for Research (AIR) study to identify predictors of Optacon success and to develop and field test appropriate Optacon training materials for use by 112 blind elementary and secondary students in 15 U.S. public and residential schools. Potential use of the Optacon (an optical to tactile conversion device that enables blind individuals to read ink print materials) is briefly discussed, a drawing of Optacon components is provided, and selected study results summarized in tabular and written form. Noted among predictors of Optacon reading proficienty are scores on intelligence and tactile-kinesthetic discrimination tests. (LH)

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Research on Reading of Ink Print by the Blind*

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Introduction

Research and development in reading devices for the blind has been and will continue to be a vital link in improved inward and outward communication with those who are handicapped through sensory deprivations. In terms of societal goals, high priority must be given to finding alternative means of reading which can alleviate the effects of the deprevation both in a functional and emotional sense. Many blind individuals have much greater potential to operate in a sighted world than is generally achieved and there is ample evidence to show that this failing is not due to lack of intellect or capacity for work. Nor is the hesitancy to undertake new experiences a sign of lack of motivation. Rather, these are consequences of a forced dependence on others--for spatial orientation, for conceptualizing the wholeness of places and things, and, of great importance, for distinguishing meaningful ink print materials, be they labels, phone books, or professional journals.

Various engineering groups have been active in the area of ink print readers, which convert optical images to either tactile or aural analogs. One of the tactile converters, the Optacon, was developed by Stanford University and the Stanford Research Institute, with federal support. The Optacon device which was evaluated in terms of educational potential in the present study is a two-handed, battery powered, portable version. Figure 1 shows the main features of the device as well as ancillary devices intended primarily for training purposes, a tracking aid and a visual display. Also available are pacing devices which deliver tactile images at uniform rates.**

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*A presentation given at the 1975 annual meeting of the American Educational Research Association, Washington, D.C. The research study was supported by the Bureau of Education for the Handicapped, USOE, under Contract #OEC-0-72-5180.

**The Optacon and associated devices are presently manufactured and marketed by Telesensory Systems, Inc., 1889 Page Mill Road, Palo Alto, California 94304.

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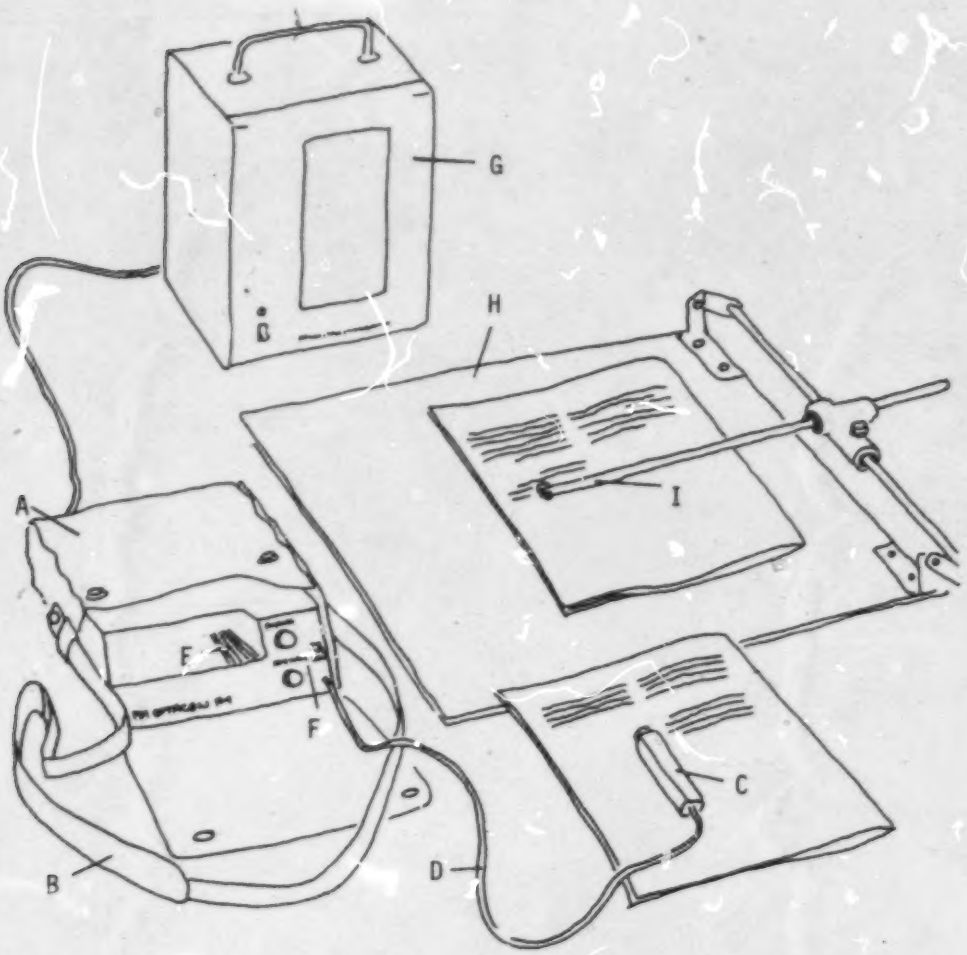

A Leather-cased Optacon Electronics
B Shoulder Strap
C Camera or Light Probe, with Zoom
D Cable
E Tactile Array (Index Finger)
F On-Off, Threshold and Intensity Controls
G Visual Display
H Tracking Aid
I Tracking Aid Guide Bar-Camera Attachment

Figure 1. Components of the Optacon device as evaluated in this study.

Need for the Study

Prior to the AIR study* the main focus of instruction and use of the Optacon in this country was with adults who acquired their own Optacon and received concentrated individual training in their use. A number of critical questions needed investigation to determine the potential of the device under "real world" educational conditions when:

- students are at different grade levels and vary in intellectual and other abilities,
- student/teacher ratios vary and Optacon equipment is shared,
- credentialed teachers or student teachers under supervision serve as instructors,
- the setting for instruction varies, and
- the time available for instruction is constrained by school schedules.

Objectives

The principal objectives of this study were:

- To conduct a field investigation in which the evaluation design would allow comparison of certain treatment variables, i.e., elementary vs secondary school level, student/teacher ratio, involvement of student teachers.
- To investigate possible predictive relationships between success in reading with the Optacon and measured intelligence, tactile ability, braille reading ability, English spelling ability, and self-concept.
- To establish the levels of reading speed and accuracy that are typically attainable and to relate these to study time.

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* Weisgerber, R.A., Everett, B.E., Rodabaugh, B.J., & Shauner, W.M. Educational evaluation of the Optacon (Optical-to-Tactile Converter) as a reading aid to blind elementary and secondary students. Final Report. Palo Alto, California: American Institutes for Research, September 1974. (AIR-34500-9/74-FR).

- To develop appropriate instructional materials at the elementary and secondary levels for teaching the tactile recognition of Arabic numerals, English letters, words and sentences, as well as reading of such material in a variety of formats, contexts, and typestyles.
- To explore the diversity of applications for which the students might find the device useful once their initial or basic instruction has been completed and they can pursue independent study.

Population

Among the schools who expressed willingness to participate, preference was given to those who were located at points providing geographical balance to the overall study and providing future demonstration capability. Efforts were also made to include at least some schools that represented each of the different instructional philosophies of residential, public itinerant and public resource schools. Altogether, 15 schools and school districts, with some 112 blind students, were involved.

To be qualified for inclusion in the main study, schools were asked to nominate students who were braille readers at 50 WPM or more, who had no additional handicaps that would interfere with learning, who were within the range of grades 4-12 and had parental or institutional consent. In actuality, about one-fourth of the students nominated by the schools fell below the 50 WPM braille standard.

A limited number of students who, on one or more of the criteria, were inappropriate to be included in the main study, were observed as special cases to further test the potential of the Optacon. The five students considered as special cases consisted of four children who were either first or second graders at the time they entered the study plus one child who was multiply handicapped.

Instructional Design

Instruction took place during three semesters. The principal objective of all initial first semester instruction was the completion of the

basic manual, since it was structured so as to develop skills thought most crucial to Optacon reading fulfillment. In the second semester, the students who had begun training in the spring completed the manual, then began a program of individual study using materials of their own selection together with supplemental monthly materials supplied by AIR. Throughout the second and third semesters students became less dependent on the teachers for close tutorial help. More and more they spent their Optacon study time reading silently and privately, only calling on the teacher when special difficulties were encountered, such as in the vocabulary and the format of some materials.

An overview of the contents of the AIR manuals places in perspective the kinds of learning experiences that were undertaken by the subjects of the study. Initial experience was given in the discrimination of basic vertical, horizontal, diagonal, and circular shapes. Letters were introduced in the approximate order of their frequency in words. Lessons within the various instructional units were addressed to specific skills development. For example, in Units 3-9 dealing with the alphabet, lessons were included for capital letters, for lower case letters and for a mixture of the two. Units 10-13 dealt with building speed, different typefaces, unusual formats and personal expression; while in Unit 14 some eight lessons were included for gaining experience in reading diverse materials, including a tape recorder guarantee, a library catalog card, a pamphlet, a booklet, a reference book and a portion of a newspaper. Unit 15, concerned with remediation, could be bypassed completely if the learner had no difficulty in recognizing or discriminating among different numerals and letters.

Some 46 Optacons and lesser amounts of ancillary training equipment were made available for purposes of the educational evaluation. At each site, "learning stations" were established to which the students reported for instruction (a suggested half hour daily during regular school hours.) However, at several sites, an itinerant teacher transported equipment between schools daily to meet with several students. Elementary and secondary level students were necessarily taught separately, since the lesson materials were designed to be age-relevant and were thus somewhat different in content.

A key instructional treatment variable was the student/teacher ratio. Ratios of 1:1 were conducted in tutorial fashion, with the teacher observing the visual display and assisting the individual student to work with an Optacon. Where 3:1 ratios were implemented, however, the instruction proceeded somewhat differently, with three Optacons being connected in a master/slave mode. Thus, only one of the three students would be tracking the camera, and it was this Optacon which would be attached to the visual display. The other two students using the slave machines would only be feeling the image as transmitted from the master Optacon and be unable (directly) to control the rate or clarity of presentation.

Results

Criterion: The first and most meaningful outcome is that of student performance in reading ink print material. Table 1 shows the reading rates, accuracy and variety of use results at the end of 24 hours (first semester) and 58 hours (second semester) for those tests taken by all main study participants. This roughly equates to one school year of study, assuming that instructional sessions run 20 to 30 minutes and absence or other factors interfere with some sessions.

After 58 hours the mean rate was 12.3 with a range from 2.1 to 37.2 WPM. Measured reading rates varied according to the type of material being read and whether the reading was silent or aloud. Not surprisingly, paragraphs based on the common 300 words proved easiest to read, at an average 14 WPM. This may reflect the ability of many students to recognize the whole word rather than depending on letter by letter decoding. Not shown, but of importance, is the fact that reading rates on regular monthly materials continued to increase in the third semester, reaching a mean of 18 WPM, with some students reaching 40-50 WPM. Analysis made clear that adequate study time is a precondition to meaningful progress in the building of reading speed. One would expect that continued study would raise the speeds still further.

While accuracy was in the 85 to 89 percent range at the first testing, a quite respectable range after two semesters of study, accuracy moved upward to a 91 to 95 percent range, an even more impressive range. In inter-

TABLE 1

SUMMARY OF OPTACON READING CRITERION RESULTS*

CRITERION	AFTER 24 HOURS N=54		AFTER 58 HOURS N=58	
	MEAN	STD.DEV.	MEAN	STD.DEV.
WORDS PER MINUTE				
SILENT	N.A.	N.A.	13.5	7.9
ALOUD	7.5	5.1	12.3	7.3
COMMON WORDS	7.6	5.8	14.0	8.9
VOCABULARY WORDS	8.4	5.1	13.5	7.7
STD. TEST PASSAGE (ORION)	7.1	4.9	10.9	6.9

	MEAN	STD.DEV.	MEAN	STD.DEV.
PERCENT OF WORDS READ ACCURATELY				
ALOUD	89.4	11.3	93.0	7.7
COMMON WORDS	87.9	17.5	95.2	6.4
VOCABULARY WORDS	89.6	12.9	94.1	7.5
STD. TEST PASSAGE (ORION)	85.5	15.3	91.0	10.3

preting these results it is clear that, when reading narrative material, Optacon students at all levels made very few mistakes in word recognition.

One assumes that an important potential value of the Optacon would be in allowing the blind reader to gain useful information from a variety of materials, not simply those that were printed in clear, non-serifed type and in a narrative format. Table 2 indicates students' level of success in dealing with seven such tests of variety of use where flexibility, tracking and manipulation of Optacon controls become critical. In each kind of item the students progressed sharply from one semester to the other in this ability. Book print, which was the least "different" from the basic instructional materials, was read acceptably by 78% of the students, while italics were more difficult. Items requiring some searching and scanning (catalogue item, medicine labels, book index) were also accomplished by a majority of the students. However, items in which the quality of print was degraded (telephone book entry, news headline) were still quite difficult, with fewer than half the students correctly identifying them.

Prediction: Of the predictor variables tested in the study, Table 3 shows that several are significantly associated with success in learning the Optacon; that is, the ability to develop reasonably good reading rates, high accuracy and some variety or flexibility of use for different print applications.

The Tactile-Kinesthetic Form Discrimination test used in this study is a very useful predictor of speed, accuracy, and flexibility of use. The test consists of common geometric forms embossed as three-dimensional figures on thin plastic sheets. Students are asked to identify the form which is different from the others in a set of forms or to identify the form that matches an example.* Inspection of the responses to items suggested that a short form of the Tactile test would serve quite adequately as a predictive tool, being correlated at the .01 level with all reading criterion outcomes.

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* Hammill, D., and Crandell, J.M., Jr. Implications of tactile-kinesthetic ability in handicapped children. Education of the Visually Handicapped, October, 1969, 1 (3), 65-69.

TABLE 2

SUMMARY OF OPTACON READING FLEXIBILITY RESULTS

	% OF STUDENTS SCORING ACCEPTABLY	% OF STUDENTS SCORING ACCEPTABLY
VARIETY OF USE ITEMS		
ITALIC PRINT	38	71
BOOK PRINT	42	78
TELEPHONE NUMBER	27	36
NEWS HEADLINE	36	48
CATALOGUE ITEM	35	60
BOOK INDEX	35	52
MEDICINE LABELS	40	71

* Includes only those subjects who completed two semesters of study.

TABLE 3

CORRELATIONS OF PREDICTORS WITH
OPTACON READING CRITERION PERFORMANCE AFTER
AN AVERAGE 58 HOURS OF TRAINING (SECOND SEMESTER)

Predictors	WPM (aloud)	WPM (silent)	Accuracy	Variety
Tactile Total	.50**	.47**	.49**	.43**
Tactile Short Form	.48**	.42**	.38**	.42**
Intelligence Total	.39**	.35**	.28*	.15
Information Subtest	.39**	.30*	.36**	.30*
Comprehension Subtest	.26*	.31*	.08	.07
Arithmetic Subtest	.53**	.48**	.44**	.33**
Similarities Subtest	.44**	.39**	.32**	.20
Vocabulary Subtest	.02	.01	-.02	.03
Digit Span Subtest	.18	.13	.03	-.14
Sex (Female)	.27*	.28*	.22*	.28*
Age	-.25*	-.23*	.01	-.30**
Average WPM Braille	.21	.21	.27*	-.03

* .05 significance level

** .01 significance level

N = 58

Another apparent predictor of Optacon reading success was intelligence as measured by the WISC and WAIS instruments. The most highly correlated aspect of intelligence was the arithmetic subtest, with correlations at the .01 level with all reading performance outcomes. The information subtest was also correlated with all reading performance outcomes. The similarities subtest was correlated with all reading performance outcomes. The similarities subtest was correlated with speed and accuracy, and the comprehension subtest with speed. The intelligence total was correlated with speed and accuracy but not with flexibility of use. It is especially interesting to note that vocabulary and digit span, for which an a priori rationale would seem plausible, did not show correlations of any meaningful nature.

A few other variables show a relationship to Optacon success on one or more of the performance measures. Female students appear to be somewhat more successful, and younger students do at least as well as older students. Braille reading ability does not appear to be a useful predictor other than that it is correlated with Optacon reading accuracy.

Treatments: Findings related to alternative instructional treatments were that:

- Optacon skills can be taught individually or in small (3:1) groups with similar results.
- Student teachers can effectively teach Optacon skills.
- Optacon skills can be taught to elementary and secondary students and, based on four special cases, even to primary level students. (AIR developed special whole-word approach reading materials for this latter purpose.)

Conclusions

The study clearly indicated that functionally blind children can benefit from regular classes of instruction in ink print reading. The Optacon would appear to be one enabling device that has merit for some students, though clearly not all of them.

There are pronounced individual differences in the reading performance levels attained, indicating that some blind students should not be channeled into Optacon instruction. A reasonable distinction can be made between low performing students and medium-to-high performing students on the basis of several selection instruments. Intelligence scores with the WISC or WAIS tests (especially the arithmetic, similarities and information subtests) can be used to help predict Optacon reading proficiency. Similarly, tactile scores obtained with the Tactile-Kinesthetic Form Discrimination test (or its short form) can be used to help predict Optacon reading proficiency.

Some students simply could not feel the tactile images satisfactorily. It is conceivable that some of them might have found the Stereotoner, an ink print reading device with auditory output, more to their liking, but this was not a part of the study design. AIR is presently conducting research on the Stereotoner in cooperation with the Veterans Administration and the National Academy of Science. Other devices, particularly the Cognodictor, which has spelled speech output, are expected to become available in the near future. It seems evident that systematic research in the area of ink print reading devices for the blind will continue to serve a useful purpose.